# RESTORATION OF THE ROTATION CENTER IN MINIMALLY-INVASIVE TOTAL HIP REPLACEMENT

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## ABSTRACT

Objective: Our aim was to evaluate the challenges in obtaining a successful restoration of the rotation center as well as a good positioning of the acetabular component when using the minimally-invasive posterior approach for uncemented total hip replacement. Methods: In a comparative non-random prospective study, 64 adult patients underwent elective total hip arthroplasty using the minimally-invasive posterior approach performed by one single surgeon. All patients included in this study had a superior and lateral migration of the rotation center of the hip in comparison to the normal contralateral hip. Patients were excluded from the study if they presented the following: diagnosis of femoral neck fracture, displasic hip types 2, 3 and 4 (Crowe's classification), osteoarthritis of the contralateral hip. Of the 64 patients in the study, 39 had a radiographic pre-op acetabular size planning equal or less than 50 mm and 25 patients had a radiographic pre-op acetabular size planning equal or more than 52 mm. We considered a good result the following goals: acetabular bend between 35 and 50 degrees, acetabular size according to the pre-op estimative with full contact in the three zones of DeLee-Charnley , a lower medial and vertical positioning of the rotation center in comparison with the pre-op values and a final limb discrepancy lower than 10 mm. Results: A better restoration of the rotation center, as well as, excellent acetabular positioning was found in patients with smaller acetabular size (equal or less than 50), p=0, 04. We must draw attention to two risks when using the minimally-invasive posterior approach: a vertical acetabular position and a lateral position of the acetabular component increasing the risk of a poor contact in the zone 1 due to an insufficient reaming of the medial acetabular host bone. Conclusion: We propose standard surgical approaches in patients with larger anatomical measurements (acetabular planning size more than 50).


***Keywords:*** *Arthroplasty, replacement, hip. Minimally-invasive surgical procedures. Human.*

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## INTRODUCTION

In the beginning of this Century, many authors started to use minimally-invasive approaches for total hip replacement.[1] With distinct objectives, among which to provide less clinical morbidity and early rehabilitation, some authors report good clinical and X-ray results in case series.[2,3]

Concerning the positioning of prosthetic components and X-ray results, we found reports of increased inappropriate positioning risk both for the acetabular component[4], and for the femoral component[5], when using minimally-invasive approaches.

The objective of our study was to assess the challenges of restoring rotation center and of a good acetabular positioning though a posterior minimally-invasive approach in non-cemented total hip replacements.

## MATERIALS AND METHODS

We conducted a prospective, comparative, therapeutic study on patients submitted to non-cemented total hip arthroplasty through posterior minimally-invasive approach. This was a two-tailed study, where the null hypothesis (H0) is the equity of a good acetabular positioning and the restoration of the prosthesis rotation center, and the alternative hypothesis (H1) is the difference between these.

All patients were selected from a single waiting list for total hip replacement in our service. The patients were previously divided into two groups according to acetabular component planning. The group of patients whose planned acetabular component's size is smaller or equal to 50 ("smaller acetabulum group") is compared to the group of patients whose planned acetabular component is larger or equal to 52 ("larger acetabulum group"). X-ray planning is made by using manufacturer's templates ("templating") at anteroposterior plane (with ampoule at 100 cm and centralized at the pubic symphysis) and at absolute lateral plane of the hip. The planning at absolute lateral position offers more accuracy to the surgeon, especially on patients where some disproportion degree is found for sagittal and coronal diameters.

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The criterion determined for the selection of the acetabular component in all cases was the largest acetabulum with 45 degrees of horizontal bending, having as medial boundary the lateral wall of the image in "Kohler's tear" and lower boundary the bilacrimal line, in addition of requiring full coverage on the three acetabular zones, following the checking of the planned size at absolute lateral plane of the hip.

All patients were operated by the lead investigator, using the posterior minimally-invasive approach.

This adapted access port from the posterior approach first described by Moore[6] is performed with the patient at lateral position. Once the 9-11 cm skin incision and the opening of gluteus aponeurosis and iliotibial tract are made, the "sparing" tenotomy of the external hip rotator muscles is provided, trying to preserve the integrity of pyriform muscle's tendon and of distal portion of femoral squared muscle. We used adapted narrow and long "Hohmann"-type retractors. We avoided excessive tension during skin retraction, displacing the surgical drape to a distal position when we accessed the acetabulum, and to proximal position when we accessed the femur ("mobile window" principle).

Surgeries were performed between July 2004 and July 2006, totaling 64 patients, 39 patients on the "smaller acetabulum" group and 25 patients on the "larger acetabulum" group.

Patients with primary or secondary hip osteoarthrosis were included in the study, in which some degree of lateral and upper migration of the hip rotation center because of lost sphericity of the femoral head and/ or presence of osteophytes existed.

Patients with spherical femoral head diagnosed with femoral neck fracture and submitted to previous hip surgery, as well as patients with hip dysplasia grades 2, 3 and 4 according to Crowe's classification were not included in the study.[7]

Death during hospitalization time was established as an exclusion criterion. The case series study is summarized on Table 1.

**Table 1 –** *Case series study*

| | Smaller acetabulum group | Larger acetabulum group | p value |
|---|---|---|---|
| Mean age (years) | 49.2 | 52.6 | 0.42 |
| Body mass index (mean) | 27.3 | 27.1 | 0.58 |
| Gender Nr of patients (males: females) | 15:24 | 20:5 | 0.002* |
| Operated side Nr of patients (right: left) | 21:18 | 11:14 | 0.60 |
| Mean incision size (in cm) | 9.2 | 9.9 | 0.09 |

Pre- and postoperative X-ray analysis was conducted by the lead investigator.

On preoperative X-ray, the following parameters were measured: location of the femoral head's rotation center, horizontal distance from the rotation center to Kohler's line and the vertical distance from bilacrimal line, as well as any discrepancy of the initial length of the limbs to bituberositarian line.[8]

These measures were reassessed after surgery, additionally to the measurement of horizontal bending of the acetabular component to bilacrimal line.

We regarded an angle between 35 and 50 degrees as satisfactory. Concerning rotation center restoration, we think that an optimal result would be the use of the preoperatively planned acetabulum with medialization and lowering of the rotation center and full coverage of the acetabular component according to De Lee and Charnley's zones.[9]

As for limb's final length, we regarded as good results any stretching not exceeding 1 cm according to X-ray criteria.

All patients remained in hospital for 4 days, undergoing early motor physical therapy and ambulating after the second postoperative day, when the vacuum drain was removed, with minimal load.

Infectious prophylaxis is provided with endovenous cefuroxime (Zinacef®) 1.5 g at each 12 hours for 48 hours, and anti-thrombotic drug prophylaxis with subcutaneous enoxaparine (Clexane®) 40 mg/ day for 30 days, as well as mechanical prophylaxis with assisted active mobilization of the three joints of the lower limb as early as the second postoperative day.

Data with normal distribution are assessed by using parametric tests. The comparison between groups is done by two-tailed t-test using a significance level of $p<0.05$.

Data not presenting a normal distribution were assessed with non-parametric tests. The comparison between both groups is made by using the two-tailed Mann-Whitney test, also adopting a significance level of $p<0.05$.

Qualitative data (non-numeric) were deployed on double-entry contingency tables and assessed using the Chi-squared test or the Fisher's exact test whenever required. A significance level of $p<0.05$ was also adopted.

Continuous variables (measurable data) are described as mean values and standard deviation or median and inter-quartile interval, depending on data distribution. Categorical variables (category-counted data) are described with frequency and percentage of valid cases. Contingency tables are built for these data, which are analyzed by the Chi-squared test or Fisher's exact test whenever possible.

This study was approved by the Committee of Ethics for the Analysis of Research Projects (CAPPESQ) and by the National Committee of Ethics in Research (CONEP).

## RESULTS

Results are presented on Table 2, where we found a lower success rate with the medialization of rotation center in patients of "larger acetabulum" group ($p=0.04$).

Considering as an excellence standard the following variables: acetabulum with 35-50 degrees of horizontal bending, medialization of the rotation center, lowering of the rotation center, use of previously planned acetabulum, and acetabular component coverage on the three acetabular zones, we had 94.8% success rate in the group "smaller acetabulum" against 76% in the "larger acetabulum" group ($p=0.04$). (Figure 1)

No patient had intraoperative complications. A patient of "smaller acetabulum" group showed deep venous thrombosis 30 days after surgery, despite of mechanical and drug prophylaxis, being successfully clinically treated. One patient of the "smaller acetabulum" group showed late dislocation secondary to trauma one year after surgery because of a fall at home, fixed by bloodless reduction.

**Table 2 –** *Results*

| | Smaller acetabulum group | Larger acetabulum group | p value |
|---|---|---|---|
| Mean acetabular angle (degrees) | 45.2 | 42.5 | 0.51 |
| Acetabula with 35-50 bending angle | 37/39 | 25/25 | 0.51 |
| Medialization of the rotation center | 37/39 | 19/25 | 0.04* |
| Lowering of the rotation center | 36/39 | 22/25 | 0.67 |
| Final acceptable limb discrepancy | 37/39 | 24/25 | 1.0 |
| Employed prosthesis Aesculap®:Lepine® | 25:14 | 10:15 | 0.07 |

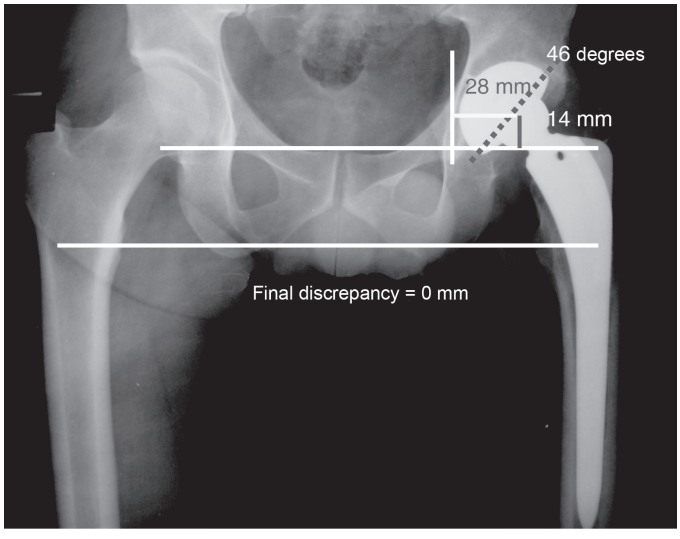


**Figure 1 –** *Postoperative X-ray measurements*

## DISCUSSION

In our case series, a younger mean age was found as compared to other authors' reports, a fact that is justifiable by the high number of patients with secondary hip osteoarthrosis (lower age group) with increased clinical complexity seeking our service.

Concerning the prevalence of males in the group of patients with acetabula larger than 52, we regard this finding as an expected event, once male patients tend to have larger anthropometric dimensions. However, we didn't find differences concerning body mass index, which could characterize a strong bias in the selection of patients.

As for the use of two different non-cemented prosthesis models, we didn't find statistically significant difference, but this fact can be considered as a bias. Many authors report distinctive models in case series, especially when more than one surgeon is involved, with a single case series using 18 different prostheses models.[10] Although the use of two different prosthesis models can be regarded as a bias, we emphasize that both are non-cemented models of prostheses sharing similar principles from a technical point of view, which, we think, do not interfere on this study's core objective, because we assessed acetabular positioning and the restoration of prosthesis rotation center only.

We had a lower success rate with medialization (p=0.04) and in obtaining an excellence standard (p=0.04) in the larger acetabulum group. Insufficient medialization when preparing the acetabulum makes surgeons to use a component that is smaller than planned or to use the planned size with a surprising lateralization and lack of coverage on zone 1 on the postoperative X-ray image. (Figure 2) In cases where there is a high technical complexity and large anatomical dimensions, we suggest the use of traditional approaches. Another issue to be discussed is the adapted instrumentation. We used adapted retractors for minimally-invasive surgery, but we didn't use adapted milling machines or guide, although navigation is not a consensus, with diverse opinions about the true benefit of this aid.[11,12]

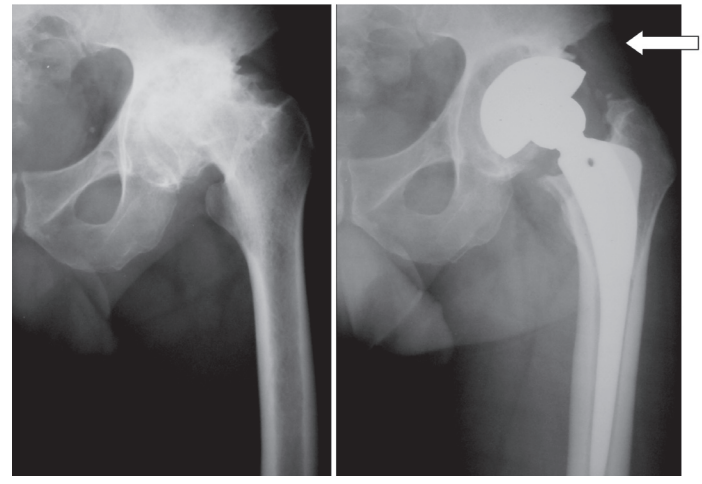

**Figure 2 –** *Severe osteoarthrosis with technical difficulty and large-sized acetabulum (58 in diameter).*

Acetabular positioning does not seem to be a problem, according to some authors using the posterior minimally-invasive approach[13-15], but most of the studies assess only vertical bending and anteversion of the acetabular component without assessing the correlation with X-ray planning ("templating") or the offsets of the rotation center.

However, with the anterior minimally-invasive approach with two incisions, technical difficulties have been reported, with surgical times of as much as 9 hours[4] and high rates of unsatisfactory results (28%) concerning acetabular positioning.[16]

We think that the biomechanical result is only one perspective of this new technique, and other aspects should be studied such as long-term clinical outcome, bleeding and morbidity, as well as complications. We also think that receptor bone bed preparation may be insufficient is visualization is not satisfactory, which might affect component's osteointegration.

## CONCLUSION

We conclude that patients whose planned acetabular component size is larger or equal to 52 may represent a technical challenge for surgeons, at risk of under-dimensioning and lateralization of the acetabular component and of the prosthesis' rotation center.

## REFERÊNCIAS


1. Wenz JF, Gurkan I, Jibodh SR. Mini-incision total hip arthroplasty: a comparative assessment of perioperative outcomes. Orthopedics. 2002;25:1031-43.
2. Berger RA. Total hip arthroplasty using the minimally invasive two-incision approach. Clin Orthop Relat Res. 2003;417:232-41.
3. Matta JM. Single-incision anterior approach for total hip arthroplasty on an orthopaedic table. Clin Orthop Relat Res. 2005;(441):115-24.
4. Bal BS, Haltom D, Aleto T, Barret M. Early complications of primary total hip replacement performed with a two-incision minimally invasive technique. J Bone Joint Surg Am. 2005;87:2432-8.
5. Woolson ST, Mow CS, Syquia JF, Lannin JV, Schurman DJ. Comparison of primary total hip replacements performed with a standard incision or a mini-incision. J Bone Joint Surg Am. 2004;86:1353-8.
6. Moore AT. Metal hip joint: a new self-locking vitallium prosthesis. South Med J. 1952;45:1015-9.
7. Crowe JF, Mani VJ, Ranawat CS. Total hip replacement in congenital dislocation and dysplasia of the hip. J Bone Joint Surg Am. 1979;61:15-23.
8. Russotti GM. Proximal placement of the acetabular component in total hip arthroplasty. A long-term follow-up study. J Bone Joint Surg Am. 1991;73:587-92.
9. DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop Relat Res. 1976;(277):166-74.
10. Kennon RE, Keggi JM, Wetmore RS, Zatorski LE, Huo MH, Keggi KJ. Total hip arthroplasty through a minimally invasive anterior surgical approach. J Bone Joint Surg Am. 2003;85:39-48.
11. DiGioia AM, Plakseychuk AY, Levison TJ, Jaramaz B. Mini-incision technique for total hip arthroplasty with navigation. J Arthroplasty. 2003;18:123-8.
12. Inaba Y, Dorr L, Wan Z, Sirianni L, Boutary M. Operative and patient care techniques for posterior mini-incision total hip arthroplasty. Clin Orthop Relat Res. 2005;(441):104-14.
13. Chimento GF, Pavone V, Sharrock N, Kahn B, Cahill J, Sculco TP. Minimally invasive total hip arthroplasty. A prospective randomized study. J Arthroplasty. 2005;20:139-44.
14. Sculco TP, Jordan LC, Walter WL. Minimally invasive total hip arthroplasty: the Hospital for Special surgery experience. Orthop Clin North Am. 2004;35:137-42.
15. Wright JM, Crockett HC, Delgado S, Lyman S, Madsen M, Sculco TP. Mini-incision for total hip arthroplasty. A prospective, controlled investigation with 5-year follow-up evaluation. J Arthroplasty. 2004;19:538-45.
16. Fehring TK, Mason JB. Catastrophic complications of minimally invasive hip surgery. A series of three cases. J Bone Joint Surg Am. 2005;87:711-4.